right ascension. To save the strain on the observer this is moved at approximately the right rate by an electric motor with suitable mechanism for giving the rate corresponding to the declination of the star. The great success of this instrument is attested by the results already published by Mr. Hough.

A full description is also given of the Victoria telescope, presented to the observatory by Mr. Frank McClean. It is furnished with a spectroscope for the determination of velocity in the line of sight, and with two large objective prisms of 24 in. aperture and refracting angles of 8° and 12° respectively. These can be used singly or together. Excellent results, including a determination of the solar parallax by Dr. Halm, have been already obtained with the line of sight spectroscope. The Cape Observatory is therefore, thanks to the generosity of Mr. McClean, admirably equipped for astrophysical work.

While the reversible transit-circle and the Victoria telescope are probably the instruments which will be most valuable to Sir David Gill's successors, it is with the 7-in. heliometer that most of his own personal observing work has been done. This instrument was obtained in 1887 to supersede the 4-in. used at Ascension. With it (partly in cooperation with Dr. Elkin) he made the well-known determinations of the parallax of the sun and of the brightest stars of the southern hemisphere, remarkable alike for the smallness of their accidental error and the care with which causes of systematic error were eliminated. In addition, the 7-in. heliometer has been used in other important investigations, particularly in the determination of the mass of Jupiter and the orbits of its satellites, researches in which two young astronomers, Mr. Bryan Cookson and Mr. de Sitter cooperated.

Sir David Gill includes an account of the Cape Photographic Durchmusterung. Knowing that this survey of the southern sky was proposed, Prof. Kapteyn volunteered to undertake the arduous work of measuring the photographs and discussing the results. From this cooperation, a catalogue containing the magnitudes and approximate positions of 450,000 stars resulted, giving a complete survey of the southern skies; it is noted that the preparation of this work first directed Kapteyn to the study of the problems of cosmical astronomy.

A very interesting account of the Geodetic Survey of South Africa is supplemented by an appendix by Dr. Wilhelm Bahn (translated from the *Beiträge zu Geophysik*) on the South African arc of meridian. Arcs of meridian were measured by Lacaille and Maclear, and between 1859 and 1862 the triangulation of the southern coast of Cape Colony was taken in hand. Soon after Gill's appointment, he pointed out to Sir Bartle Frere the advantage to be gained by a comprehensive survey, and recommended a gridiron system of chains of principal triangulation extending over the Cape Colony, the Orange Free State, Natal, and the Transvaal. This work has been carried out under the direction of Sir William Morris in the field, with Sir David Gill as scientific adviser, who kept constantly in view the service to geodesy which would be derived from the measurement of a large arc on the 30th meridian of east longitude. This was afterwards continued through Rhodesia, and the extreme arc measured extends over nearly 22° from 31° 36′ S. lat. to 9° 41′ S. lat. There are six base-line determinations along the arc, and sixty determinations of astronomical latitude. The measures of the South African arc of meridian indicate a somewhat larger terrestrial spheroid than that of Clarke, and are in accordance with the results obtained by Hayford in the United States. The extension of this arc to join the Egyptian arc, and the connection round the eastern end of the Mediterranean to join the Russian arc measured by Struve is of great scientific importance, and, as Sir David Gill points out, offers no very formidable difficulty if international cooperation is secured.

In this article only portions of the volume have been touched upon. Sir David Gill is to be congratulated on the production of a work the historical and narrative portions of which are of interest to all men of science, while the technical portions are of the greatest value to astronomers. He may be assured that others will find guidance and inspiration in this history of the Cape Observatory, as he himself did in Struve's account of Pulkova.

F. W. DYSON.

SCIENTIFIC METHODS OF IDENTIFYING PICTURES.

UP to the present time the identification of works of art has been entrusted entirely to the art expert, who brings to bear upon the problem his wide experience and artistic training; and, in addition, it is probable that among those engaged in buying and selling pictures, many devices kept as trade secrets are useful in identifying pictures. While not for a moment denying that the final word should lie with the trained art expert, it is of interest to see how far scientific methods can be brought to bear upon this problem. The first step in this direction is a careful study of the history of pigments. By the examination of ancient documents, such as the illuminated manuscripts of the monks, Venetian Ducali, and the Coram Rege Rolls, it has been possible to plan out the history of pigments probably with sufficient accuracy for practical purposes, and to fix the dates approximately of certain pigments which appear and others that disappear from the artist's palette. This method, where applicable, may be regarded as infallible, as the presence of a pigment of a date more modern than the date at which the picture is supposed to be painted proves either forgery or repainting, and a careful microscopic examination make it quite possible to tell whether the picture has been repainted or not.

This, however, does not settle the authorship of the picture, and there are certain periods in the history of art during which for a considerable length of time there was no change in the artist's palette. It is necessary, therefore, to bring other methods as well to bear upon the problem. One of these is the study of mediums used at different dates, and in this study sufficient progress has been made to prove it of use for dating purposes. But, as will be obvious to a chemist, the analytical difficulties here are much more serious.

The microscopic study of pictures by magnifying under low powers revealed remarkably distinctive characters in the artists' brushwork; and the more pictures examined, the more valuable did the method appear as a trustworthy means of determining the authorship of a picture. There are probably certain schools of art to which the method does not apply. A great deal of the sixteenth-century Italian work, for instance, is handled in a very similar way, and it may be very difficult to apply this method successfully to some of these painters. But there is a wide field in which the artist has left his individual mark upon his paint, and has so drawn for the future a signature which it is impossible to forge. One of the most interesting revelations is that many of these touches are so fine as to be really beyond the limit of unaided sight. For instance, the brushwork of Teniers and of Watteau can be magnified up to four or five diameters, revealing an accuracy of touch and a delicacy of modelling and a drawing of lines which are themselves in some cases not more than one-tenth of a millimetre in diameter, and yet are put in with perfect certainty. The study of foliage is also of special interest, as each man's method of handling foliage is characteristic.

Among the large number of photographs taken it is difficult to know which to select as examples of the method, but probably those will be of most interest which illustrate an actual problem. Such a problem is offered by the picture in the National Gallery known as "The Old Gray Hunter," which is signed "Paul Potter," and has been stated by no less authority than Dr. Bredius to have been painted by Verbeecq, a contemporary artist. There is another Paul Potter in the National Gallery (No. 849), the authenticity of which has never been questioned, and which a comparison of photomicrographs with photomicrographs of a pedigree Paul Potter in The Hague Museum shows to be genuine.

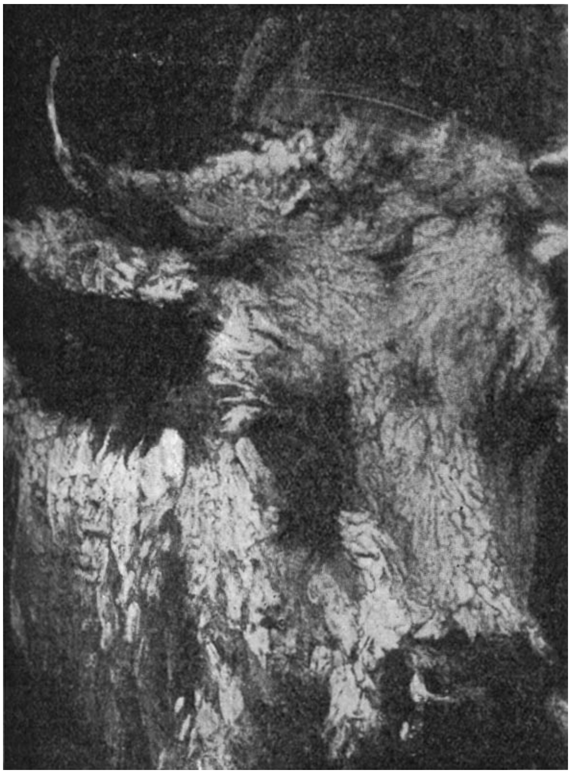

FIG. 1.—Brushwork of the head of a cow in an undoubted picture by Paul Potter in the National Gallery.

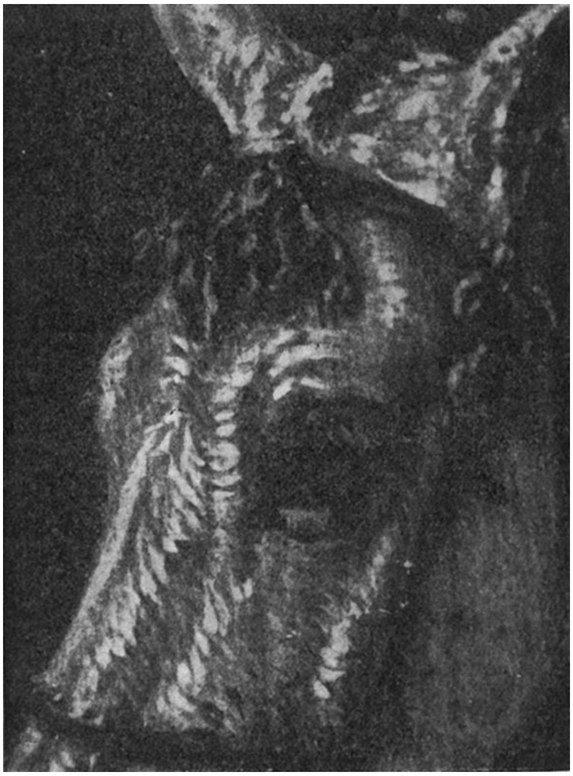

FIG. 2.—Brushwork of the head of the horse in "The Old Grey Hunter," shown by the touch not to be by Verbeecq, and inferior to Paul Potter's best work.

The first photograph here reproduced (Fig. 1) is the head of a cow in this genuine Paul Potter for the comparison with the head of the horse (Fig. 2) in "The Old Gray Hunter." It is at once obvious that, while there are certain similarities in the brushwork, the painting of the horse's head is by a very inferior hand to that of the painting of the cow. The probability is, then, that it is not Paul Potter's work, although this cannot be considered as absolutely proved.

The method of photomicrography has been applied to the examination of pictures by other artists. One example examined was in a private collection, and it had every appearance of being by Teniers. Curiously enough, there appeared in it an old man who is to be seen in more than one of Teniers's genuine works. The picture, therefore, had come from Teniers's studio, as the same model was to be found in it, or it was a copy and a forgery. The two photographs reproduced in Figs. 3 and 4 show the old man as painted by Teniers in the well-known picture in the National Gallery of Teniers's "Chateau," and the face painted in the private picture. The difference of brushwork in the modelling of the face is at once apparent, while the careless painting of the beard, when compared with Teniers's, is clearly revealed.

A. P. LAURIE.

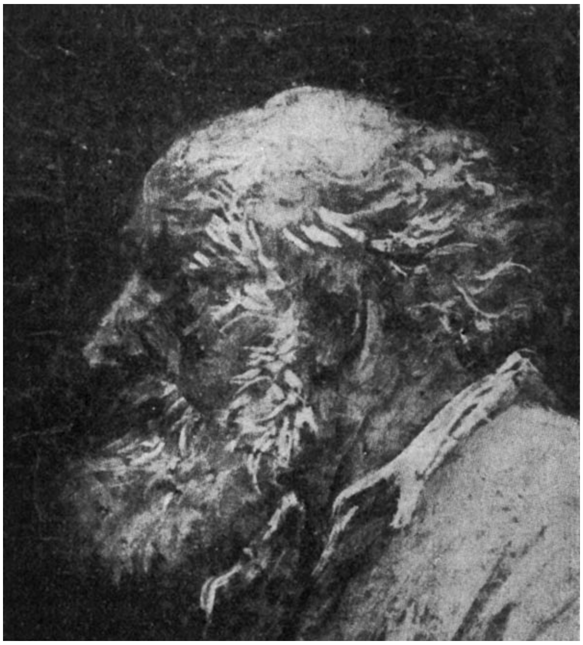

FIG. 3.—Brushwork of the head of an old man, from a picture in the National Gallery known to be Teniers.

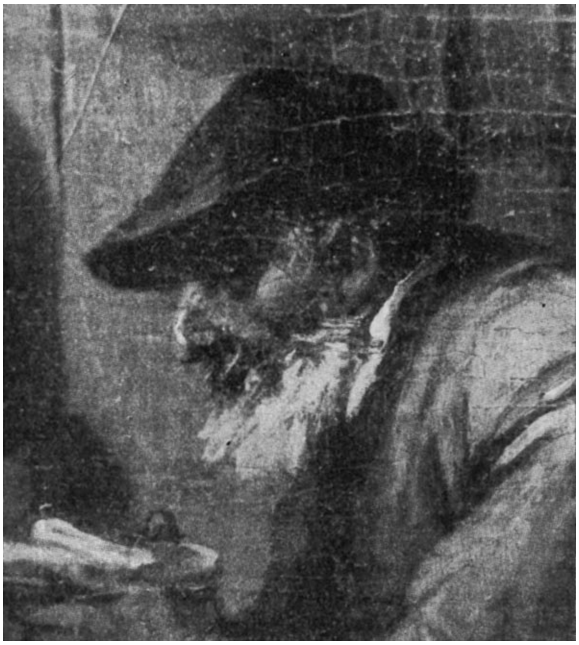

FIG. 4.—Head from a picture described in a private collection as by Teniers but shown by the brushwork not to possess Teniers's touch.

AMERICAN AND GERMAN INVESTIGATIONS ON SOIL FERTILITY.[1]

THERE is always a refreshing novelty about the publications of the American Bureau of Soils that makes an irresistible appeal to the student of agricultural science on this side of the water. We may not always agree with the conclusions reached, and we may sometimes think that the facts might be interpreted otherwise, but we cannot deny the ingenuity and freshness of the work done.

Of all difficult problems connected with the soil, few are more promising than the investigation of the remarkable carbon compounds produced during the decay of plant residues in the soil. It is known in a general way that cellulose and protein (two important plant constituents) are broken down in the soil to ammonia and carbon dioxide, but the intermediate products have scarcely been investigated in spite of the great biochemical interest of the process. Dr. Schreiner and his colleagues have recently attempted the problem, and their results are set out in a series of bulletins issued from the bureau.

Examination of the soil has shown that numerous nitrogen compounds can be obtained from it as the result of applying certain methods of extraction; among them are hypoxanthine, xanthine, guanine, adenine, cytosine, as well as the split-products of the proteins. There can be little doubt that these arise from the decomposition of decaying plant residues and other substances added as manure. The fact of their existence in the soil is of considerable interest, but it is still more interesting to inquire whether they serve any useful purpose in relation to plant growth. The current view is that they decompose to form nitrates, which are then absorbed by the plant, and built up once more into complex proteins, nucleoproteins, &c. Messrs. Schreiner and Skinner suggest that some of them at any rate are absorbed as such, and utilised direct for the formation of protein. One is accustomed to this view in animal physiology, but hitherto it has not been commonly held among plant physiologists. Experiments are here described, showing that histidine, creatinine, and asparagine caused increases in green weight in wheat, even when a

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[1] "Nitrogenous Soil Constituents and their bearing on Soil Fertility." By Oswald Schreiner and J. J. Skinner. U. S. Department of Agriculture, Bureau of Soils, Bull. No. 87.

"Occurrence and Nature of Carbonised Material in Soils." By O. Schreiner and B. E. Brown. *Ibid.* Bull. No. 90.

"Studies in Soil Catalysis." By M. X. Sullivan and F. R. Reid. *Ibid.* Bull No. 86.

"Pflanzenwachstum und Kalkmangel im Boden." By A. Wieler. (Bornträger, Berlin). Price 14 marks.